Space Weather Technical Forecast

Issued on Sunday, 22 October 2023 at 01:23 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Weak CME arrivals possible on Day 1 (22 Oct) with a slight chance of G1/Minor Storm intervals.

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity as recorded at GOES16 has been Low over the past 24 hours, with only isolated low level C-class flares. There are currently six sunspot regions on the visible disc, all of which are relatively small and simple. AR3469 (Dao/Beta) in the northwest and AR3470 (Cao/Beta) in the northeast have both shown some minor development in recent hours. AR3464 has recently departed across the western limb.

No Earth directed CMEs have been seen in coronagraph imagery during the last 24 hours.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by ACE and DSCOVR at L1, has been at background levels throughout and is currently around 300 km/s although may be exhibiting waning signs of slight enhancement from a CME arrival on 20 Oct. The density has been predominantly average or just above average with a peak of 18ppcc at 21/1330 UTC, density fell to below average levels around 21/2100 UTC. The IMF was generally at moderate levels until around 21/1300 UTC, after which it has been weak. The Bz was moderately southward directed until around 21/1300 UTC, and has since weakly fluctuated but remaining southward varying between 0 and -9nT. The phi angle was positive (away from the Sun) until 21/1300 UTC and has since fluctuated with periods of negative (towards the Sun) and positive phi angle.

Geomagnetic activity was initially Active (Kp 4) with two intervals at G1/Minor Geomagnetic Storm (Kp 5) level. Activity has been Quiet to Unsettled (Kp 1-3) since 21/0900 UTC.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux was at background levels.
GOES16 high energy (greater than 2MeV) electron flux was predominantly at background levels. The associated 24-hour fluence was well below the Active (1e8 integrated pfu) threshold. The observation at 22/0000 UTC was 1.16e6 integrated pfu.

Four-Day Space Weather Forecast Summary
Solar Activity: Solar activity is expected to remain Low, with an ongoing chance of isolated C-Class flares. There is a slight chance of M-flares, with the probabilities increasing slightly through the period given the potential for new or returning regions, and for regions on the disc to develop.

Solar Wind / Geomagnetic Activity: The geomagnetic forecast is complex and carries high uncertainty. There remain two probable Earth-directed CMEs in the forecast which may produce glancing impacts on Day 1 (22 Oct). There is potential for some minor High Speed Stream (HSS) coronal hole fast wind enhancement from CH63/- by Day 3 (24 Oct). Geomagnetic activity is expected to be predominantly Quiet to Unsettled (Kp 0-3). The potential for CME arrivals on Day 1 give a chance of Active (Kp 4) intervals and a slight chance of a G1/Minor Geomagnetic

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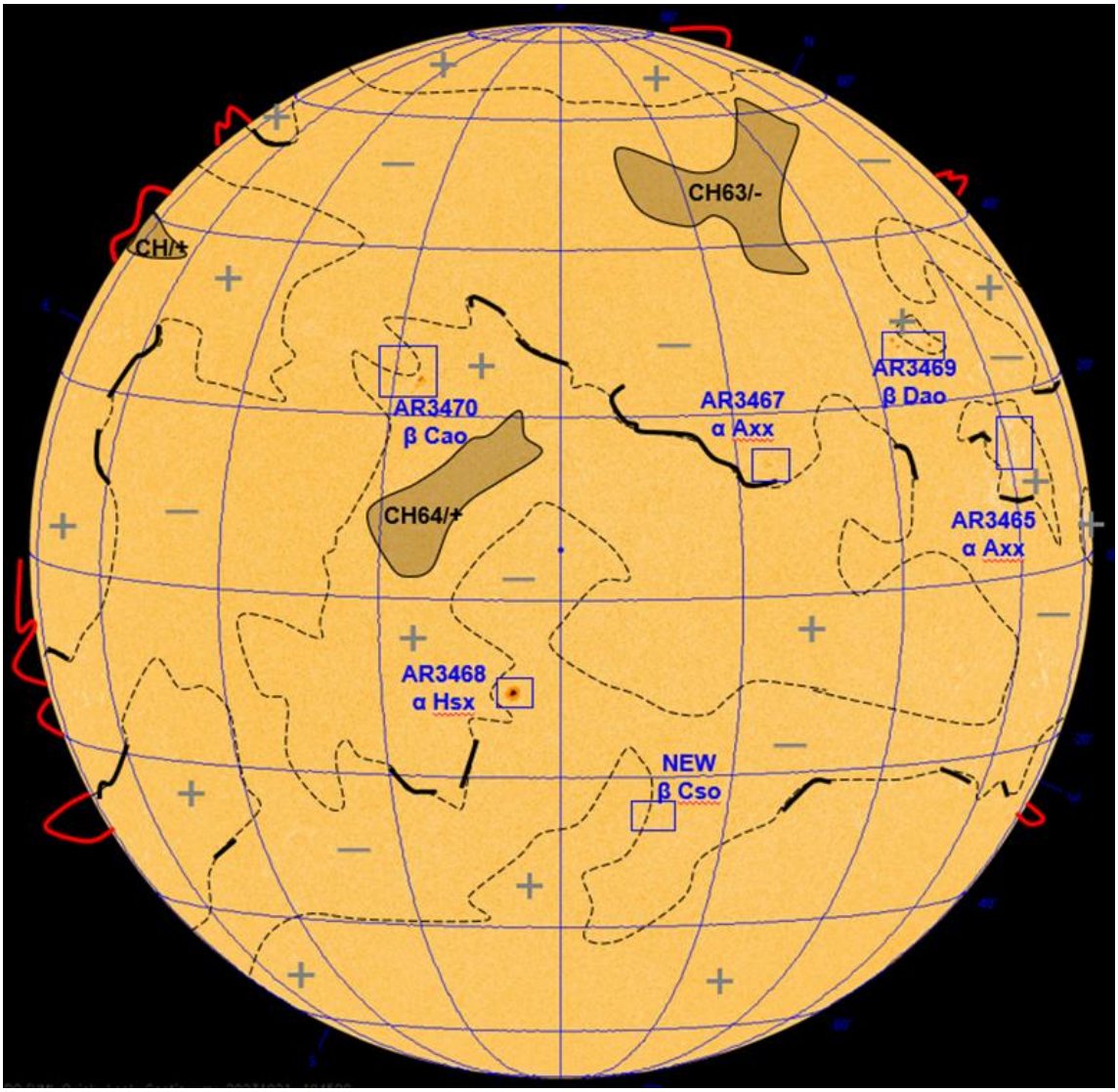
Storm (Kp 5). By Day 3 Unsettled to Active (Kp 3-4) intervals are then possible with the onset of the anticipated minor coronal hole fast wind.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is expected to persist at background levels.
High energy electron flux (greater than 2MeV) is expected to be at background levels, perhaps rising to moderate depending on the strength of any CME or HSS enhancements. The associated 24-hour electron fluence is expected to remain below Active (1e8 integrated pfu).

Figure 1. Solar Analysis Valid 21/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

Two Earth-directed CMEs currently feature in the forecast, with significant uncertainty in arrival times. The first associated with a filament eruption near ex-AR3463 off the southwest disc early on 17 Oct is expected to largely miss, passing ahead of Earth. The second was observed lifting off of the southeast of the disc early 18 Oct. This features has been assessed as passing behind Earth shortly afterwards, also with a slight chance of glancing impacts. These two features may result in glancing blows on Day 1 (22 Oct), although there is low confidence in this.

There is the potential for some minor enhancement to the solar winds from late Day 2 (23 Oct) or Day 3 (24 Oct) associated with a HSS from CH63/-. However, the combination of the position of this coronal hole feature on the disc and its negative polarity would signify only minor enhancement with winds potentially increasing to elevated levels, otherwise they are expected to remain slow-ambient. MOSWOC Enlil is considered to be providing a reasonable steer for the trend of winds through the period, although is too strong initially. MOSWOC SWPM is considered too early with the onset of any HSS enhancement.
There are also a number of filaments which, should they lift-off from the surface of the Sun, pose a risk of producing an Earth-directed CME, complicating the geomagnetic forecast towards the end of the period.

Geomagnetic activity is expected to be predominantly Quiet to Unsettled (Kp 0-3) with a chance of Active (Kp 4) intervals and a slight chance of a G1/Minor Geomagnetic Storm (Kp 5) on Day 1 (22 Oct) should the forecast CME arrivals take place. From late Day 2 (23 Oct) or more likely Day 3 (24 Oct) Unsettled to Active (Kp 3-4) intervals are then possible with the arrival of the anticipated minor coronal hole fast wind.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	20	5	10	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
17/1430	Partial	Filament	SW	420 km/s	22/0600 UTC +/- 6hrs	Low Confidence. Glancing blow.
18/1132	Partial	Filament	SE	610 km/s	22/0800 UTC +/- 6hrs	Low Confidence. Glancing blow.

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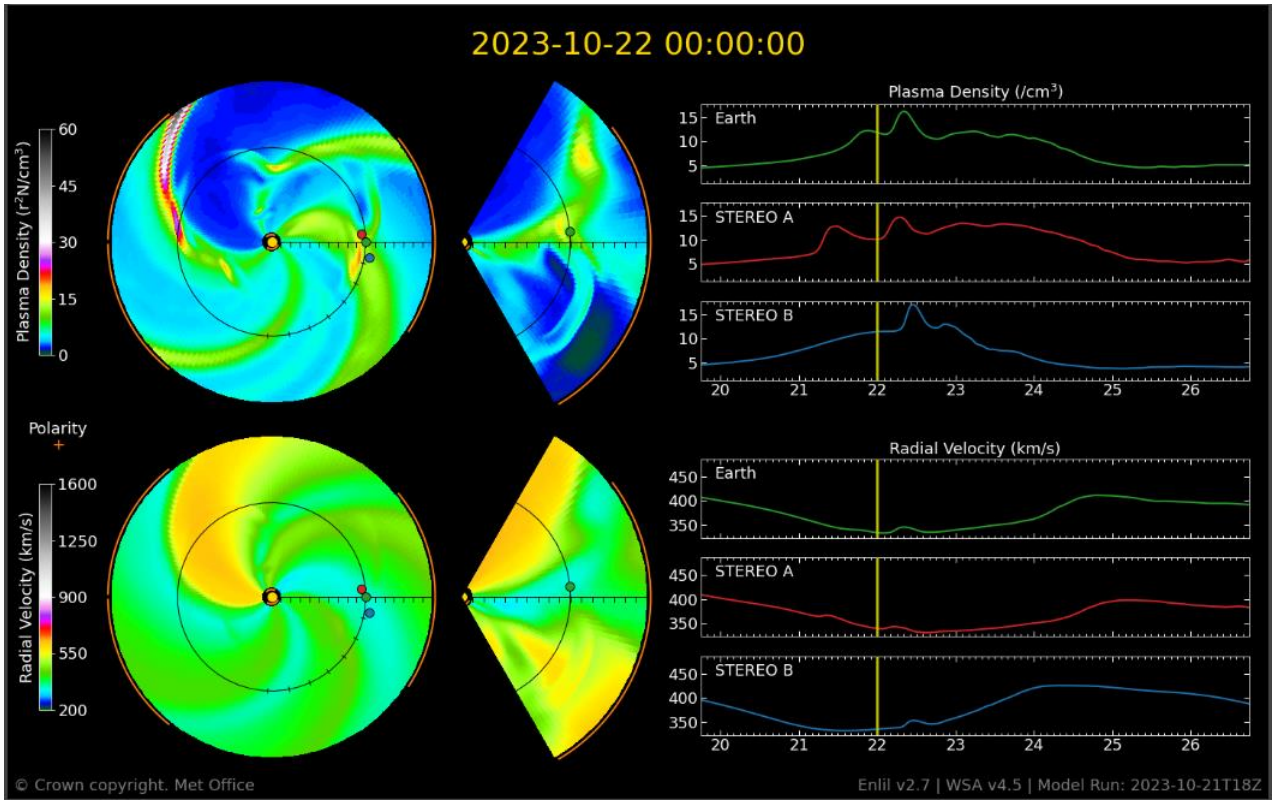
Figure 2: MOSWOC Enlil and Ensemble, showing potential CME arrival Day 1 and spread of solutions for later HSS enhancement.



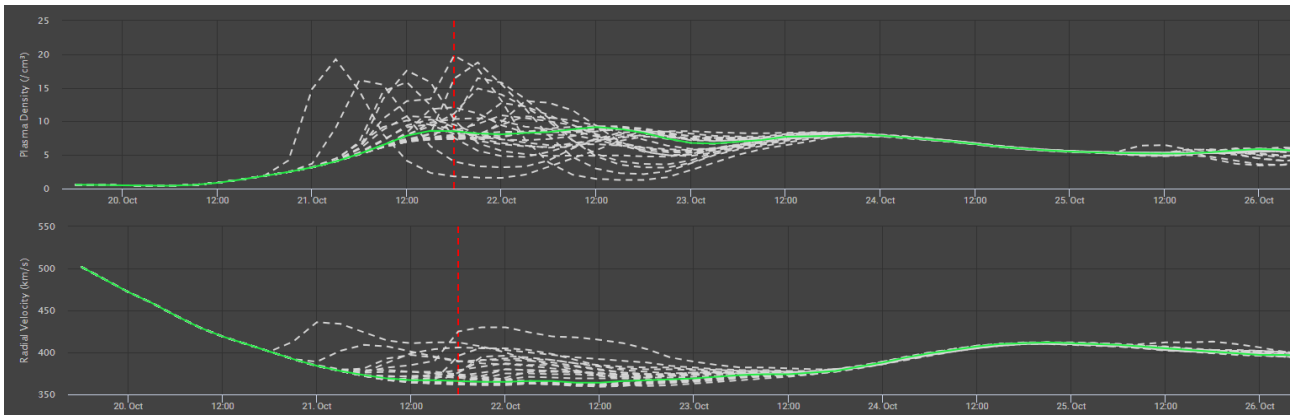


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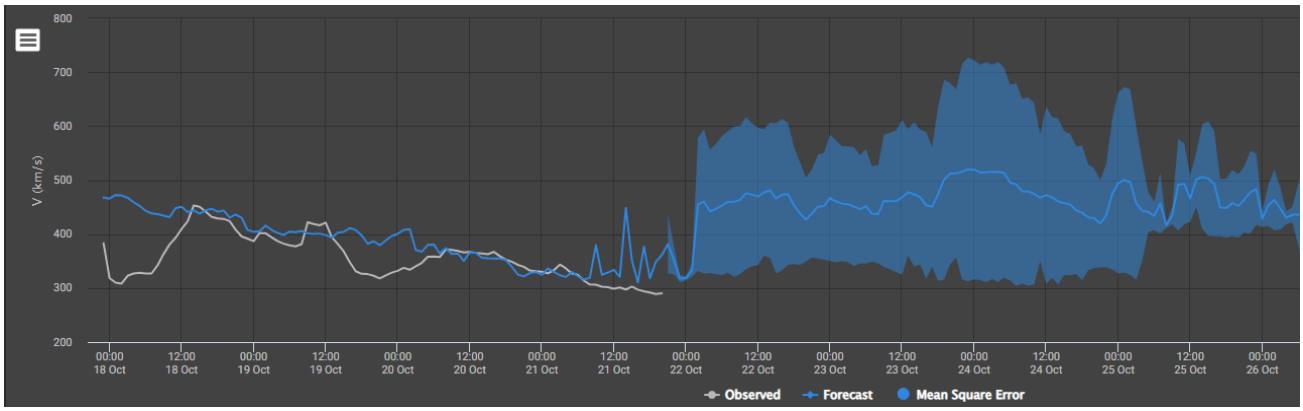
Figure 3: MOSWOC SWPM considered to be too early with the onset of HSS and with winds that are too fast.



Radio Blackouts - X-Ray Flares:

There are currently six regions on the visible solar disc, all of which are relatively small and simple. AR3469 (Dao/Beta) in the northwest is the most complex region on the disc. AR3470 (Cao/Beta) in the northeast has seen further development, with the proliferation of some small spots and penumbra developing on its trailing portion.
AR3468 currently retains its uni-polar classification, however pore development in a trailing portion of plage will continue to be monitored. AR3464 has recently departed beyond the western limb.

Activity is likely to remain Low with further isolated C-class flares expected. There is a slight chance of an isolated low level M-class flare should any regions develop further as they rotate across the visible disc. New or returning regions could rotate onto the disc from the far-side on Days 3-4 (24-25 Oct) which may increase the flare risk slightly, as is indicated in the slight increase in probabilities.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	5	5	10	10
Very Active	R3 to R5 X Class	No	1	1	1	1

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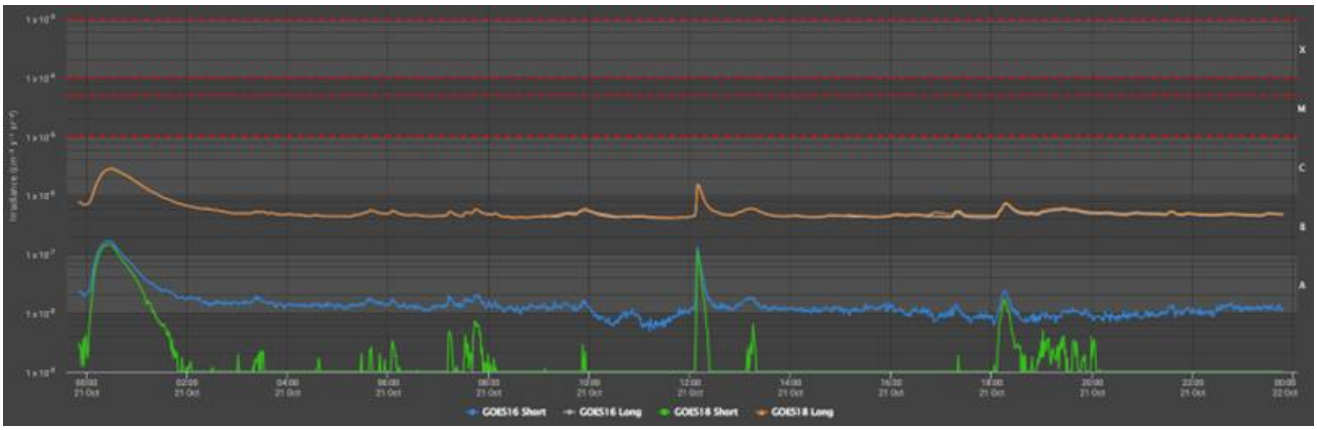
Figure 4: GOES-16/GOES-18 X-Ray 24-hour trace



Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is expected to persist at background levels with an ongoing absence of significant regions on the visible disc.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	1	1	1
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

High Energy Electrons Event (≥ 2MeV):

Electron flux observed by GOES16 at GEO is currently at background levels. Solar wind enhancements are possible through the coming days, with the possibility of weak CME arrivals on Day 1 (22 Oct) and the onset and influence of a HSS from Day 3 (24 Oct). Low confidence in detail with any enhancement expected to be largely weak. Influence from these features could increase the electron flux in the Van Allen belts during the period, which could bring periods of moderate flux, most likely towards the end of the period.

The associated 24-hour fluence is expected to remain below the Active threshold, as supported by MOSWOC REFM output. However, the model does not take into account any potential CME arrivals. Fluence levels may rise towards the end of the guidance period as is reflected in a slight uplift for probabilities.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	5	10	10
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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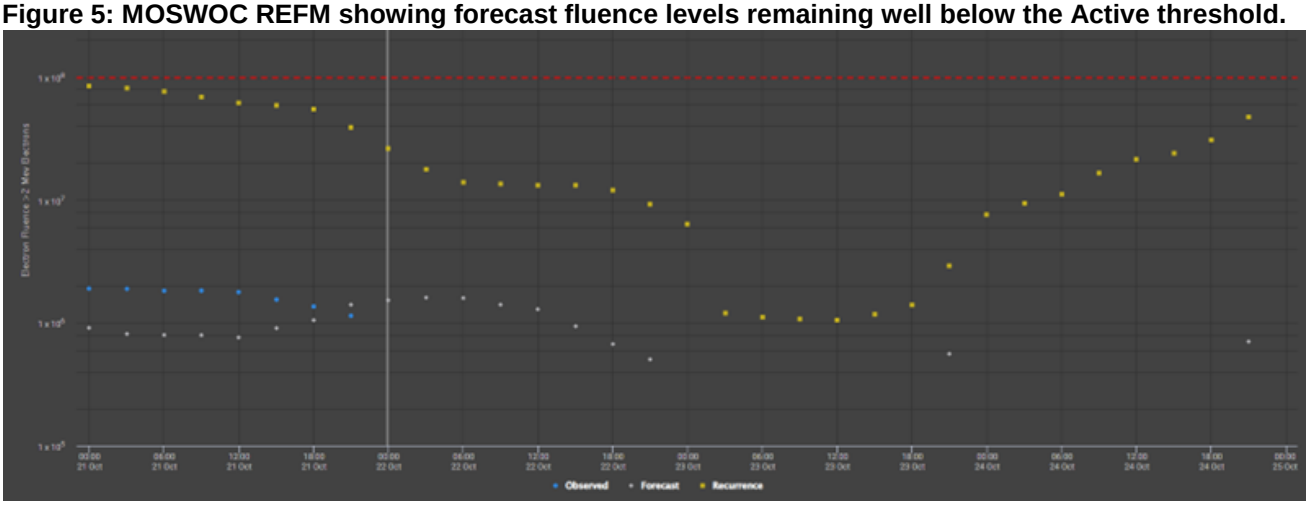
Figure 5: MOSWOC REFM showing forecast fluence levels remaining well below the Active threshold.



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